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ABSTRACT

To investigate methods of improving both employees' productivity and the quality of their work life, workers from four businesses were surveyed before and after their organizations implemented a total employees involvement program. Survey questions covered employees' perceptions of (1) the quality of the product produced, (2) the leadership's concern with workers' views, (3) the amount of work expected from them, (4) the possibility of advancement, (5) the effectiveness of the organization's structure, and (6) the psychological and financial rewards received for their work. While problems in data collection prevented a time series analysis, survey results did indicate that the factory reporting the most dramatic increase in productivity and product quality also had the highest criterion ratings. There is no direct evidence, however, that these improvements in employee productivity and work attitudes were due to the total employee involvement program. Further refinement of the survey instrument is needed before this research can be interpreted confidently. (MM)

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EMPLOYEE INVOLVEMENT, ATTITUDES, AND PRODUCTIVITY IN HIGH TECHNOLOGY MANUFACTURING: A TWO-YEAR, EXPERIMENTAL STUDY

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ABSTRACT

An historical perspective on prior employee involvement research and the development of the Quality-Circles-type intervention is described. A detailed account of an attitudinal study conducted over a two-year time span including over 600 employees in four high-technology, manufacturing units of a large main-frame computer company is discussed. An analysis of variance approach was used to examine the data. Results indicated a strong effect for location (Factory) but little evidence of change over time. Interpretations and conclusions are cautious due to the complexity and dynamic nature of the environment.

A need for further, careful study in the industrial environment is expressed.

EMPLOYEE INVOLVEMENT, ATTITUDES, AND PRODUCTIVITY IN HIGH TECHNOLOGY MANUFACTURING: A TWO-YEAR, EXPERIMENTAL STUDY

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INTRODUCTION

In 1982, the first two authors presented a paper reporting empirical data on an organizational intervention, which included a quality-circles-type program as part of the intervention process, in a relatively small circuit board factory of a multi-national U. S. electronics firm (Stinnett & Perrill, 1982). Results of pre- and post-test measures of attitude were compared to measures of productivity and related to a "comparison factory."

The present paper extends and broadens that study in a number of dimensions. First, we now have a third measure in the original circuit board factory. Second, the "pre-test" of last year in the "comparison factory" was followed by an organizational intervention similar to that in the circuit board factory; and we now have post-test data from that facility. In addition, we now have both pre- and post-test data from another facility which has not yet undergone the planned organizational intervention, thus providing us with "control group" data rather than the "comparison factory" information of 1982. Specific details of the design of the study will be found in the Methodology section of this paper.

Background and Rationale

Current popular literature emphasizes the need for American industry to improve its productivity. The organization in which the current study took place shares that view and believes that participative management and employee involvement must be part of the thrust toward improving product quality, the quality of working life, and productivity. The position of the organization seems to be that, in all too many instances, its employees have become fragmented and disenfranchised groups of people who have difficulty making a meaningful contribution to their work. This disenfranchisement frustrates, increases stress, affects everyone in the organization, and manifests itself in low productivity, poor quality, high absenteeism, negative attitudes, and inability to consistently meet corporate goals.

To counter this trend, and with the belief that most employees honestly desire to improve their productivity as well as the quality of their work life, the organization has embarked on a series of interventions designed to increase employee involvement through processes intended to create more open systems, allowing each person to be involved in his or her owrk in a more meaningful way. Moreover, management of the organization believed that the creation of open systems would facilitate the exchange of information among components and sub-systems of the organization in ways vital to the survival of those components and to the organization, itself (see, for example, Hawkins & Preston, 1981, pp. 33-43; and Buckley, 1967). In addition, management believed with Myers (1981) that the achievement of organizational objectives requires the understanding and support of company goals by all members of the organization, and such concern for production must be balanced by a "high concern for people on the assumption that maximum efficiency can be best sustained through committed people who recognize a 'common stake' in

the achievement of organizational goals" (Myers, 1981, p. 220). Thus, the organizational intervention reported here was designed to facilitate interpersonal communication among all employees, horizontal communication across components and sub-systems of each factory or facility, and downward communication of management's needs; and it literally forced information upward through the organizational system. The intervention was planned and implemented by an interdisciplinary group of facilitators who placed a high priority on developing interpersonal trust among all employees as they worked to develop more participative managers and improve quality of working life in ways that would permit employees to improve both product quality and productivity.

The behavioral science principles on which this kind of intervention must be based have been developed over a long period of time (see, for example: Roethlisberger & Dickson, 1939; Maslow, 1954; Herzberg, Mausner, & Snyderman, 1959; McGregor, 1960; Likert, 1961; and Herzberg, 1966). More specifically, however, the organizational intervention which provided data for this study was undertaken in an attempt to move the factories and facilities involved in the direction of Likert's "System 4" organization (Likert & Likert, 1976). This general organizational system has been described, in part, as follows:

> The human organization of a System 4 firm is made up of interlocking work groups with a high degree of group loyalty among the members and favorable attitudes and trust among peers, superiors, and subordinates. Consideration for others and relatively high levels of skill in personal interaction, group problem solving, and other group functions also are present. These skills permit effective participation in decisions on common problems. Participation is used, for example, to establish organizational objectives which are a satisfactory integration of the needs and desires of all the members of the organization and of persons functionally related to it. Members of the organization are highly motivated to achieve the organization's goals. High levels of reciprocal influence occur, and high levels of total coordinated influence are achieved in the organization. Communication is efficient and effective. There is a flow from one part of the organization to another of

> all the relevant information important for each decision and action. The leadership in the organization has developed a highly effective social system for interaction, problem solving, mutual influence, and organizational achievement. This leadership is technically competent and holds high performance goals (Likert & Likert, 1976, p. 16; paraphrasing Likert, 1961, p. 99)

Although the generalizability of these principles has been challenged, Likert defends them as consistent with the direction that most people would like their organization to move, although intervention strategies and implementation plans must be adapted to the unique requirements of each individual organization (Likert & Likert, 1976 pp. 51-55). The specific adaptations employed during this organizational intervention are reported in detail in the Methodology section, below.

METHODOLOGY

Data reported in this paper were collected from an organization with a global approach to organizational intervention, which they call Total Employee Involvement. This approach to the process of organizational change in the direction of more participative management includes a quality-circles-type process as a major structural element, but the intervention strategies go far beyond most QC implementation plans. Each of the factories or facilities chosen for this study was selected because it was a definable "work unit," where the manager of the factory or facility had within his authority all (or nearly all) the resources necessary to produce the product or a segment of the product; and, for each factory or facility, every employee (including professional and technical support personel) was a member of one or more Employee Involvement Teams (the QC-type process). In addition, this organization feels it is important that each team's leader be the supervisor or manager of that area, that each team has the appropriate technical support (at least one engineer per team in manufacturing), that each team has been

trained in quality circles techniques, and that each team has ample opportunity to express its needs concerning problems outside its domain as well as being able to solve some of its own problems (Stinnett, 1982, p. 22).

The change process is being implemented within relatively autonomous work units (labeled "Factories" in Figure 1) ranging from 50 to 300 employees each, permitting the authors to make rough comparisons across units. Cautious interpretation of the results will be made because of several important differences in the work units included in the study. The basic elements of the change process and the major differences among the work units will be described in the following sections.

The Change Process

The overall change strategy includes three phases and three broad categories of activity. The phases are labeled "unfreezing, changing and refreezing," (Lewin, 1951). Each phase includes activities in each of the categories referred to as, "structural change, training, and assessment." Structural changes in the unfreezing phase include influencing the reporting relationships in the total organization so that each work unit becomes relatively autonomous. For instance, rather than having all engineering support being managed in one, large central department, appropriate engineers are assigned to the work unit manager. Similar changes are made where possible in other support functions such as maintenance and finance. The number of changes and the resulting degree of autonomy of the work unit thus varies from unit to unit according to organizational restraints and demands. Also included in structural changes is the formation of various ad hoc and

LOCATION	ATTITUDE MEASURE (2/81)	INTER-VENTION	ATTITUDE MEASURE (8/81)	INTER-VENTION	Current *ATTITUDE MEASURE (10-11/82)	Projected INTER-VENTION	ATTITUDE MEASURE (Date=?)
Factory #1	@	X	@	X	@	X	@
Factory #2			@	X	@	X	@
Factory #3			@		@		@
Factory #4					@	X	@

Figure 1: Schedule for intervention in four factories.

permanent groups within the units.

During the unfreezing phase a planning group and a core group are established. The planning group includes the management of the work unit, supervisors, critical support persons, and those responsible for the change process (referred to as implementers). This group designs an overall plan for the implementation within the work unit and makes initial decisions about the resources required. The core group includes about 25% of the total work unit and represents all levels and functions within the unit. The function of this group is to promote rapid diffusion of information and to develop a sense of ownership of the change process within the unit. The "core group" drafts a "manifesto," a document which articulates a dream of how the organization could be. This document is shared and modified by all members in the work unit, and the final document provides a target, an ideal toward which all activity in the unit is directed (Stinnett, 1982, p. 21). Training in group process, problem solving, and organizational development concepts is conducted for managers, engineers and supervisors during this phase. Assessment includes individual, group, and organization-wide activities. Managers participate in workshops in which they receive feedback from peers, subordinates, and trained, clinical psychologists on their own behavior and personal style of management. Baseline productivity and product quality data are collected and examined. Attitude survey data are collected and reviewed.

During the changing phase, employee problem solving groups (teams), which include all employees within the unit, are established and trained. Each group begins regular meetings (normally one hour per week) during which they learn and use quality-circles-type problem solving techniques.

Management, too, is provided with a structure (called a "Bridge Team") which provides a clearly defined mechanism for solving problems which fall outside a team's domain and for effectively communicating management actior co employee teams. Other structural interventions include inter-shift meetings; all-employee, informative meetings; and brief supervisor area meetings. During these monthly informative meetings of the whole work unit and weekly meetings in the supervisor's area, employees are provided with information about the state of the business and where the factory or facility stands in terms of its goals. A major training intervention in this phase is an intensive communication skills workshop for all managers, supervisors, engineers, inspectors, and hourly group leaders. All employees whose roles require them to influence the behavior of other people participate in this workshop. In addition, facilitators provided many hours of personal coaching and feedback concerning behavior in team meetings and in day-to-day activities on the job (Stinnett, 1982).

Assessment is ongoing during this phase and includes periodic attitude surveys (approximately each six months), structured interviews with key individuals, charts of productivity, and quality data which are reviewed in supervisor area meetings, unit informative meetings, and periodic meetings with hourly core group members during which informal attitude data are collected and reviewed.

The refreezing phase includes restructuring where needed and the identification of key persons within the unit who will receive additional training in group dynamics and organizational development, and who will assume the role previously held by the professional implementers. De-

cisions about additional structural changes needed and additional training or assessment needs will be made by the core group at this time.

Factory Number One

The work unit labelled "Factory #1" was a small sattelite factory which produced internal layers which are later combined to form multi-layer, circuit boards. The manufacturing process is a series of chemical, mechanical, and electrical processes each of which is dependent upon the prior operation. Quality depends upon careful handling and a fairly high skill level on the part of operators. This factory is located in a separate facility approximately 40 miles from the parent company which produces large, main frame computers. The factory employed about 125 people and was acquired by the parent company about six months prior to the implementation of the change process. The work force was relatively young and inexperienced. The facility was modern, equipment was new and up-to-date. The surroundings were clean, attractive and convenient. Most employees worked on first shift, with a small second shift which was eliminated about three months after the beginning of the change process. The attitude survey (the source of the data being examined in this paper) was administered to all 125 employees in February, 1981. In March, the hourly employee groups were started. The following months showed rapid improvements in productivity and quality. Through attrition (voluntary quits, promotions to positions in other factories), the work force was reduced from the previous 125 to its current 70. The rate of production approximately doubled, the total cost per unit was reduced by approximately 50% and

the scrap rate was reduced to less than 2% (from approximately 18%). The factory began to receive considerable attention and recognition from management at the parent factory, and from corporate headquarters.

The attitude survey was administered a second time in October, 1981. The following month, the maintenance of the change process was assumed by the managers of the factory. The original implementers were released from that assignment to begin the change process in factory number two. The attitude survey, however, is always administered and analyzed by the original implementers, the third time in October, 1982.

Factory Number Two

This factory constructs multi-layer circuit boards utilizing the internal layers produced at factory number one. This factory is unique from factory number one in several important ways. There are many more different types of products (circuit boards) produced and the specifications for each product are more complex. The flow of work on any given day or week is much less predictable for the unit as a whole, as well as for each work station. While many of the manufacturing processes are the same, there are several additional processes. The facility is much older, less attractive, less convenient and less clean. It is located adjacent to the parent company. The work force is older and more experienced.

The implementation of the change process, which began in March, 1982, proceeded in much the same fashion as in factory number one, but several events occurred which were unique and could very plausibly have influenced the outcomes of the change process. The original work force (225 employees) changed dramatically in the twelve-month period between the first and second administration of the attitude

survey (October, 1981 and October, 1982). There was a large turnover of employees. Two layoffs occurred. Many new openings in another factory attracted numerous factory number two employees. A total of approximately 125 employees left the factory for one reason or another. About 30 of these were replaced (a number of these replacements were employees who were demoted during the layoffs). The current work force is approximately 125 to 130. A long-awaited facilities improvement plan was postponed indefinitely. There were significant changes in management at all levels whithin the factory, including the plant manager. Several of the technical staff took positions in other parts of the company and some were not replaced, leaving the technical resources somewhat overburdened.

Factory Number Three

This factory completes the circuit board manufacturing process, assembling various components and adding small integrated circuits and wiring where needed. There are approximately 350 employees in this factory. Many of the same conditions which exist in factory number two were present. The layoffs similarly impacted factory number three, although the total amount of turnover was somewhat less. The authors note here that the attitude survey given in October, 1981, was for a small, non-random subsample of this population. By coincidence, that subsample was most heavily influenced by the layoffs, producing a considerably reduced sample. A change of location and extensive improvements in the technology, as promised by management, were occurring during the second administration of the attitude survey (October, 1982).

Factory Number Four

A single administration of the attitude survey has occurred in this factory (October, 1982). Less dependent on the other factories, factory number four relies on more advanced technology to produce logic units for a new product. The factory is new, clean and up-to-date. The work force is mixed in age and is highly skilled. The total work force is about 225 people.

Attitude Survey

The survey instrument consists of 108 five-point Likert-type items designed around six components of a descriptive organizational model. Some modification of the total survey resulted from tailoring items to particular factories and the removal of some items from the first administration due to low item reliabilities. A total of 77 items are common to all administrations and are the source of the data examined in this paper. The components constitute a model which is intended to allow employees to respond to all aspects of their workplace and, as such, constitute a very broad view of the organization. The following paragraphs define each component and illustrate sample items. Reliabilities are displayed in Table 1.

Quality

These scales are intended to measure employee's perception of the organization's commitment to producing a quality product. (9 items, ex. "Quality is more important than quantity here.")

Leadership

Worker's views of their managers and supervisors are measured by these 25 items. (ex. "Management almost always follows through in solving problems that we point out to them.")

Table 1. The reliability of each criterion measure at each point in time, and the reliability of the change score for each criterion measure.

Criterion Measure	α_1	α_2	α_3	$\Delta\alpha_{21}$	$\Delta\alpha_{32}$
Quality	.50	.74	.80	.15	.61
Leadership	.93	.86	.93	.87	.89
Measurement	.79	.64	.80	.70	.72
People Development	.84	.85	.85	.72	.78
Structure	.74	.75	.80	.62	.71
Reward	.83	.82	.85	.60	.73

Measurement

These nine items indicate how well employees understand the measurement of their work and the performance of the factory. (ex. "It is very clear how much work I'm expected to do each day.")

People Development

The issues in these 14 items relate to employee's perception of their own personal development and growth opportunities. (ex. "I believe I have a good opportunity for job advancement.")

Structure

These 11 items serve as indicators of workers' perception of the effectiveness of the organization's structure. The productivity and frequency of meetings; the availabiltiy of appropriate resources; accessibility of management are issues concerning structure. (ex. "Most of our meetings are very productive.")

Reward

Both psychological and financial reward are examined in these nine items. (ex. "I am well paid for my work.")

Data Analyses

The rationale for the appropriate analyses, as well as the results are discussed in the following sections.

RESULTS

These data naturally lend themselves to time series analyses or to analyses of change scores. Neither of these options was pursued in this paper, since there were methodological exigencies which precluded their use. First, there was considerable S attrition. For example, in Factory #1 approximately 33% of the sample was lost from time one to time two. Approximately 67% of the sample was lost from time two to time three. In Factory #2 approximately 67% of the sample was lost from time two to time three. In Factory #3 approximately 94% of the sample was lost from time two to time three. This S mortality was due to a variety of circumstances, e.g., absence, lay-offs, promotion, etc. Regardless of the source of the attrition, analyses of the change scores, or correlational analyses over time, would be performed on very small samples. Moreover, these samples may well not be representative of the population of workers at their respective factories.

Second, the analysis of change scores is often marred by the problems of the unreliability of change scores (e.g., see McNemar, 1969, 173-176). To some extent this state of affairs exists in these data. In Table 1 the reliability coefficients (Cronbach's α) for each of the six criterion measures are presented. From this table it is clear that, on the whole, the difference scores are less reliable than the scores at each of the three time points. Given that unreliability has the systematic effect of attenuating correlations, an analysis of change scores would prove less than fruitful, since the relationships between or among variables would tend to be obscured.

Thus, these analyses are not presented. Rather, two static analyses are presented. First, the mean scores for each criterion variable are pre-

sented as a function of both factory and time, and observations are made concerning these effects. Second, since there are data for each criterion variable at each factory at time three, these data are analyzed as a function of factory.

The former are presented in Table 2. Ss are nested within factories, but they are neither nested nor crossed with time. The former would not have been allowed by the organization studied; the latter was made impossible due to S attrition. Thus, no formal analysis of these data, such as the analysis of variance, is possible. On the other hand, some observations of Table 2 do prove instructive.

First, there does not appear to be a substantial effect for time. Put another way, the criterion scores are approximately the same at all time points. Second, there does appear to be a substantial effect for factory. Factory #1 Ss rate their factory higher on all criterion variables than do Factory #2 Ss and Factory #3 Ss. The latter two groups do not appear to differ from each other. Third, there appears to be a small factory X time interaction. Factory #1 and Factory #2, especially the latter, produced decreases in the criterion variables to a greater extent than Factory #3. Since the former two factories contained the quality circle intervention, and Factory #3 did not, one might be tempted to conclude that the quality circle intervention produced lower perceptions of the criterion variables than did the control group.

This inference is unwarranted. First, the magnitude of the mean increases and decreases are small, suggesting that they may well be within sampling error of zero. Second, there is a large difference between factories in initial score on all of the criterion variables; Factory #1 is high relative to Factories #2 and #3. In fact, Factory #1 initial scores are close to the maximum for each of the criterion variables (the maximum

Table 2. Criterion variables presented as a function of factory and time.

		FACTORY 1			2			3		
		T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
Quality (45)	$\bar{X}$	35.96	35.79	35.57	---	31.58	30.33	---	31.82	32.68
	s	3.26	3.10	4.27	---	4.70	5.21	---	4.42	4.57
	N	68	67	69	---	164	135	---	84	245
Leadership (125)	$\bar{X}$	90.52	86.31	90.29	---	81.64	81.41	---	79.98	79.72
	s	15.74	15.68	15.30	---	11.83	15.21	---	11.52	16.18
	N	67	67	69	---	160	134	---	80	238
Measurement (45)	$\bar{X}$	30.83	34.13	35.13	---	28.83	28.15	---	27.93	28.78
	s	5.60	5.84	4.91	---	4.72	5.66	---	4.15	5.79
	N	69	68	69	---	162	137	---	82	243
People Development (80)	$\bar{X}$	56.25	56.72	56.50	---	51.24	52.55	---	47.72	51.41
	s	8.92	9.51	8.26	---	8.87	9.27	---	8.58	8.75
	N	68	67	68	---	161	134	---	78	246
Structure (55)	$\bar{X}$	35.21	35.55	37.54	---	31.81	29.06	---	30.38	31.06
	s	5.69	5.00	4.83	---	5.67	6.17	---	5.26	5.97
	N	68	67	69	---	164	137	---	82	249
Reward (45)	$\bar{X}$	34.13	33.62	33.37	---	30.58	31.43	---	29.67	31.61
	s	6.09	5.34	6.68	---	5.48	5.64	---	6.14	5.88
	N	67	68	67	---	165	137	---	82	249

for each criterion variable is presented in parentheses in Table 2). This result suggests that scores may have regressed to the mean. Regression to the mean can result for at least two reasons. On one hand, certain substantive processes may produce the effect. On the other hand, error of measurement may be sufficient to produce regression to the mean (McNemar, 1969, 176-179).

Testing for regression to the mean is straightforward. Simply, if the initial score is negatively correlated with its respective change score, i.e., if $r_{1,\Delta 1}$ is negative, then there is evidence consistent with the hypothesis of regression to the mean. If such a result occurs, then the question of whether the regression effect is real or an artifact produced by error of measurement remains. This question may be addressed by correcting the $r_{1,\Delta 1}$ correlation (see, Hunter & Cohen, 1974) for error of measurement. If the corrected correlation is negative, then there is evidence consistent with the hypothesis of real regression to the mean. If the corrected correlation is zero, or positive, then there is evidence consistent with the hypothesis of a regression to the mean artifact produced by error of measurement. These correlations are presented in Table 3. Clearly there is evidence of regression to the mean; there are substantial negative correlations between initial score and change score for all criterion variables. Moreover, it is clear that this regression effect is consistent with the hypothesis of a measurement artifact, since the corrected correlations are all very near zero. Therefore, error of measurement may have produced what is an apparent factory X time interaction.

Third, data are not available for Factories #1 and #2 at time one. It is conceivable, for example, that scores on the criterion variables decreased from time one to time two at these factories. If such were the case, then the reverse inference would be more likely, i.e., that quality

Table 3. Correlations and corrected correlations between initial score and change score for each criterion variable.

Criterion	$r_{1,\Delta 12}$	r'	$r_{2\Delta 23}$	r'
Quality	-.59	.00	-.35	-.01
Leadership	-.45	.00	-.41	.00
Measurement	-.52	-.02	-.47	-.01
People Development	-.38	.00	-.60	-.01
Structure	-.64	-.02	-.38	-.01
Reward	-.52	-.01	-.45	-.01

circle intervention improves S ratings on the criterion variables.

The criterion ratings obtained at time three are broken down by factory and presented in Table 4. An unweighted means analysis of variance of these data is presented in Table 5. The analysis requires comment. Because of the vast discrepancy in cell size, the unweighted means analysis is not optimal for all purposes. On the other hand, because the sum of squares were decomposed in this analysis in order to illustrate certain features of the data, the unweighted means analysis was chosen. With other algorithms the sum of squares for decomposed effects do not always sum to the total between groups sum of squares. These analyses were performed using another algorithm, and the same statistical inferences were drawn. Moreover, the effects sizes were not substantially different from those presented in Table 5. Thus, the unweighted means analysis gives a reasonable representation of the effect of factory on the criterion variables.

From an observation of Table 4 it is clear that the primary difference in criterion ratings occurs between Factory #1 and the other factories. Reward is an exception; both Factories #1 and #4 are substantially higher than Factories #2 and #3. In addition to the standard analysis of variance, these effects were tested. Thus, in Table 5 the source of variance termed, "model", tests the hypothesis that Factory #1 differs from the other factories, which in turn do not differ from each other. The lone exception is reward in which the hypothesis tested is that Factories #1 and #4 are higher on the criterion variable than Factories #2 and #3, and that the former two factories and the latter two factories do not differ from each other. The source of variance termed, "residual", refers to the total effect of factory less the effect of the proposed model. The other two sources of variance are standard; "Factory" is the between groups effect,

Table 4. Criterion ratings at time three as a function of factory.

		FACTORY			
		1	2	3	4
Quality	$\bar{X}$	35.57	30.33	32.68	31.77
	s	4.27	5.21	4.57	4.58
	N	69	135	245	165
Leadership		90.29	81.41	79.72	82.78
		15.30	15.21	16.18	14.96
		69	134	238	166
Measurement		35.13	28.15	28.78	29.87
		4.91	5.66	5.79	5.26
		68	137	243	168
People Development		56.50	52.55	51.41	54.61
		8.26	9.27	8.75	7.34
		68	134	246	161
Structure		37.54	29.06	31.06	30.85
		4.83	6.17	5.97	6.65
		69	137	249	164
Reward		33.37	31.43	31.61	33.80
		6.68	5.64	5.88	4.97
		67	137	249	166

Table 5. Unweighted means analysis of the effect of factory on the six criterion variables.

QUALITY

Source	SS	df	MS	F	p	η^2	r	r'
Factory	2251.61	3	750.54	34.19	< .05	.14	-	-
Model	1820.57	1	1820.57	82.94	< .05	.12	.34	.38
Residual	431.04	2	215.52	9.82	< .05	.02	-	-
S/Factory	13391.08	610	21.95	-----	----	.86	-	-
Total	15642.69	613	-------	-----	----	1.00	-	-

Fmax = 1.49

LEADERSHIP

Source	SS	df	MS	F	p	η^2	r	r'
Factory	9904.57	3	3301.52	13.79	< .05	.06	-	-
Model	9191.52	1	9191.52	38.41	< .05	.06	.24	.25
Residual	713.05	2	356.53	1.49	>.05	.00	-	-
S/Factory	144318.51	603	239.33	-----	----	.94	-	-
Total	154223.08	606	-------	-----	----	1.00	-	-

Fmax = 1.17

MEASUREMENT

Source	SS	df	MS	F	p	η^2	r	r'
Factory	4668.28	3	1556.09	52.70	< .05	.21	-	-
Model	4435.05	1	4435.05	150.19	< .05	.20	.44	.49
Residual	233.23	2	116.62	3.95	< .05	.01	-	-
S/Factory	18069.65	612	29.53	------	----	.79	-	-
Total	22745.93	615	-------	------	----	1.00	-	-

Fmax = 1.39

PEOPLE DEVELOPMENT

Source	SS	df	MS	F	p	η^2	r	r'
Factory	2316.71	3	772.24	10.78	< .05	.05	-	-
Model	1515.71	1	1515.71	21.17	< .05	.03	.18	.20
Residual	801.00	2	400.50	5.59	< .05	.02	-	-
S/Factory	43330.14	605	71.62	-----	----	.95	-	-
Total	45646.85	608	-------	-----	----	1.00	-	-

Fmax = 1.60

STRUCTURE

Source	SS	df	MS	F	p	η^2	r	r'
Factory	6418.45	3	2139.48	60.20	< .05	.22	-	-
Model	6044.57	1	6044.57	170.08	< .05	.21	.46	.52
Residual	373.88	2	186.94	5.26	< .05	.01	-	-
S/Factory	21860.17	615	35.54	------	----	.78	-	-
Total	28278.62	618	-------	------	----	1.00	-	-

Fmax = 1.90

Table 5. (cont.)

REWARD

Source	SS	df	MS	F	p	η^2	r	r'
Factory	676.70	3	225.57	6.61	< .05	.03	-	-
Model	659.89	1	659.89	19.32	< .05	.03	.17	.19
Residual	16.81	2	8.41	1.00	>.05	.00	-	-
S/Factory	21000.71	615	34.15	-----	----	.97	-	-
Total	21677.41	618	------	-----	----	1.00	-	-

Fmax = 1.81

and "S/Factory" is the within subjects effect.

Since the sample size for this analysis is so large, 607-619 depending on the criterion variable, the significance test information is not extremely useful. Put another way, with such a large N almost all effects are statistically significant; even when there are small effect sizes. Thus, effect size information, eta squared, Pearson's r, and Pearson's r corrected for error of measurement in the criterion variable, is presented for each analysis. Moreover, since the focus of the analysis was effect size, rather than the significance test, no multivariate analyses of variance were performed.

The results are clear. The model provides a close fit with the data. The vast majority of the effect for factory is due to the predicted model(s). Put another way, the residuals are small, even though often statistically significant.

While the size of the effect of factory differs across criterion variables, generally factory is a good predictor of the criterion score. Such is especially the case for both measurement ($\underline{r}'$ = .49) and structure ($\underline{r}'$ = .52). Factory has a considerably smaller effect for both people development and reward ($\underline{r}'$ = .20 and .19 respectively).

Thus, Factory #1 appears to be higher on the criterion variables than the other factories. With the exception of reward, these other factories do not differ from each other in criterion scores. Whether this effect is due to the quality circle intervention is speculation. While Factory #1 contained the intervention, Factory #2 did as well, and there were no differences between Factory #2 and the other factories in which there was no intervention (with the exception of reward). On the other hand, it is possible that the intervention

requires a lag in order to take effect, and that since Factory #1 had the intervention for a longer period, the intervention took effect in Factory #1 but not in Factory #2. A satisfactory answer can be obtained only by further measurement of these criterion variables.

DISCUSSION

Few conclusions can be made with confidence. According to the six criterion variables; quality, leadership, structure, measurement, people development and reward, Factory #1 is consistently rated higher than the other three factories except for reward which is rated similarly in Factory #4. Although dramatic improvements in productivity, product quality and lowered cost occurred in Factory #1, there is no evidence that these changes were due to the intervention described in this paper. Nor is there evidence that the attitudinal differences in Factory #1 can be attributed to the intervention. There are several plausible explanations of the outcomes reported here.

Hidden Results

The intervention may have actually produced the predicted results but those results were obscured by a myriad of measurement problems, statistical artifacts and confounding effects. Because of the complexity of the environment, the multiple event nature of the implementation procedures and variations in the subject populations, the attitude questionnaire may have been an inappropriate measuring device or may have been inadequately sensitive to actual changes which occurred.

Casual observation indicates that employees in Factory #1 are extremely proud of their successes and are far more satisfied with their work place than they were in March, 1981. The absence of detectable

change in the questionnaire data may be due to a ceiling effect (means on several of the criterion measures are very high) or perhaps to considerably increased expectations (increased awareness on the part of employees may cause them to be more critical of their environment).

Actual Results

The intervention may have produced no attitudinal change in employees. Factory #1 may be a better place to work than the other factories and no amount of tinkering may have much impact on that. Since no usable productivity data are available, it is impossible to determine whether or not the intervention had a direct effect on production and quality while bypassing employee attitudes. The improvements in productivity and product quality evidenced in Factory #1 may have been a direct effect of technological changes and have no bearing on employee attitude.

Fluctuation

Increases and decreases in employee attitudes may have occurred with greater frequency than the administrations of the survey. High and low ebbs may have gone undetected or been caused by other organizational events coincidentally with the administration of the questionnaire.

One example of this was the announcement of the December, 1982, layoff. Although the announcement actually occurred after the time 3 administation of the survey, rumors of the impending announcement were widespread in all factories, especially in Factories #2 and #3. Enthusiasm for any human relations program was surely at a low ebb for employees with the spectre of a layoff coming at any time.

Future Considerations

A thorough examination of the measuring instrument is clearly warranted. A factor analysis may indicate a superior organization of components. That is, the criterion measures of quality, leadership, measurement, people development, structure and reward may be inappropriately grouped. It may also be that a long, cumbersome survey is an inappropriate device to use in the highly complex, dynamic environment described here.

Quality-Circles-type interventions of the type outlined in this paper are currently planned for Factories #3 and #4. The authors intend to reexamine the instrument and to explore alternate instrumentation prior to the onset of these activities. Additional non-intervention factories will also be identified and included in the data base for future analyses.

One problem with the current procedures is the multiple-activity nature of the intervention. The authors also hope to examine specific components of the intervention in more controlled conditions than have been possible here.

Summary

Although the results reported here are not especially illuminating, the need for careful field studies is important enough to continue the effort until a satisfactory explanation can be found. Until then, the authors vow not to become zealots for a cause.

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